MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2015/2016

PGC0225 – GENERAL CHEMISTRY

(Foundation in Life Sciences students only)

06 OCTOBER 2015
2.30 p.m – 4.30 p.m

(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of **6** pages only excluding the cover page.
2. Answer **ONE** out of **TWO** questions in **Section A**, and **ALL** questions in **Section B**.
3. Please write all your answers in the answer booklet provided.
4. Distribution of marks for each question is given.
5. Calculator is permitted.

SECTION A [20 MARKS]

Instructions: Answer **ONE** out of **TWO** questions.

Question 1 [20 marks]

a. A tablet for an upset stomach contains 300 mg of $C_7H_5BiO_4$ or Bismuth subsalicylate. If you take two tablets, how much Bi are you consuming?
[Atomic mass: C = 12.0; H = 1.0; Bi = 209.0; O = 16.0]

[3 marks]

b. Write a balanced equation to describe the following reactions:

(i) The complete combustion of C_8H_{18}.
(ii) Reaction of aqueous copper (II) hydroxide with aqueous hydrochloric acid.
(iii) Hydrogen sulfide reacts with sulfur dioxide to produce sulfur and water.

[3 × 2 marks]

c. What concentration of NaCl finally results in mixing 2.0 L of 4.0 *M* NaCl with 3.0 L of 1.5 *M* NaCl plus sufficient water to dilute the solution to 10.0 L?

[3 marks]

d. Calculate the energy that is required for the decomposition of 5.0 g of $H_2O(l)$ (at 1 atm and 25°C) into its gaseous elements, given the following reaction:
[Atomic mass: H = 1.0; O = 16.0]

$$H_2(g) + O_2(g) \longrightarrow H_2O(l) \qquad \Delta H = -286 \text{ kJ}$$

[3 marks]

e. (i) Calculate the mass of carbon tetrachloride produced by the reaction of 100.0 g of carbon with 100.0 g of chlorine.
[Atomic mass: C = 12.0; Cl = 35.5]

[3 marks]

(ii) If we produce 54.25 g of carbon tetrachloride, what is the percentage yield?

[2 marks]

Continued.....

Question 2 [20 marks]

a. Calcium hydroxide and hydrobomic acid react as follows:
[Atomic mass: Ca = 40.0, H = 1.0, O = 16.0, Br = 80.0]

$$Ca(OH)_2(s) + HBr(aq) \rightarrow CaBr_2(aq) + H_2O(aq)$$

(i) Balance the above chemical equation.

[1 mark]

(ii) How many grams of HBr are needed to produced 0.125 mol of $CaBr_2$?

[2 marks]

(iii) If the reaction is carried out by combining 1.24 g of $Ca(OH)_2$ with 2.65g of HBr, what is the theoretical yield of $CaBr_2$ expressed in grams?

[3 marks]

b. The oxidation of glucose, $C_6H_{12}O_6$, to produce carbon dioxide gas and liquid water molecules is a basic metabolic process in all life. In cells, it is performed by a complex series of enzyme-catalyzed reaction.

(i) Write a balanced equation for this oxidation process.

[1 mark]

(ii) Given

Compound	H_f^O (kJ/mol)
$CO_{2(g)}$	-393.5
$H_2O_{(l)}$	-285.8
$O_{2(g)}$	0
$C_6H_{12}O_6$	-1277

Determine the H^O_{rxn} for this process?

[3 marks]

(iii) Is this an endothermic process or an exothermic process? Explain.

[2 marks]

c. For the following reaction:

$$Al(OH)_3(s) + 3HNO_3(aq) \longrightarrow Al(NO_3)_3(aq) + 3H_2O(l)$$

How many liters of 0.33 *M* HNO_3 are needed to neutralise 42.8 g of $Al(OH)_3$?
[Atomic mass: Al = 27.0; O = 16.0; H = 1.0; N = 14.0]

[5 marks]

d. Differentiate between specific heat (s) and heat capacity (C), and state the relationship between both of them.

[3 marks]

Continued.....

SECTION B [80 MARKS]

Instructions: Answer **ALL** questions.

Question 1 [20 marks]

a. Calculate the energy of a photon of light with $\lambda = 480$ nm.
[Planck constant, $h = 6.63 \times 10^{-34}$ Js; Speed of light, $c = 3.00 \times 10^{8}$ m/s]

[2 marks]

b. Rank the following orbitals in order of increasing energy:

$2p$, $4s$, $1s$, $3d$, $5s$, $3s$, $2s$

[2 marks]

c. Write the electron configurations of the following elements and ions. [4 marks]

(i) S	(ii) O^{2-}	(iii) Cl	(iv) N^{3-}
(v) B	(vi) Ca^{2+}	(vii) Al^{3+}	(viii) Mg

Which of these atoms and ions are isoelectronic? [1 mark]

d. (i) Why is the radius of a positive ion less than that of the corresponding atom?
[1 mark]

(ii) Which ion or atom has the largest radius: Mg, Na, Na^{+}, Mg^{2+}, Al? Explain.
[3 marks]

e. State the maximum number of electrons that can be accommodated in:

(i) a shell with $n = 4$
(ii) the $4f$ subshell
(iii) a single $5f$ orbital

[3 × 1 mark]

f. Identify by number (1A-8A) the main-group of the periodic table to which the described element (X) belongs, in each of the following cases.

(i) X commonly forms the ion X^{2-}.
(ii) X reacts with water according to the equation
$X(s) + 2H_2O(l) \rightarrow X(OH)_2(aq) + H_2(g)$
(iii) X exists as molecules, X_2; its hydride has the formula HX.
(iv) X is a metal which reacts with oxygen to produce the peroxide, X_2O_2.

[4 × 1 mark]

Continued.....

Question 2 [20 marks]

a. Provide a short description of the primary bonding in the following compounds:

(i) KCl (ii) Au (iii) CH_4

[3 × 2 marks]

b. Draw Lewis structures of:

(i) HOBr (ii) $COCl_2$

[2 × 2 marks]

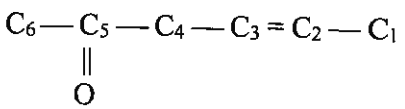
c. Fill in the following table (the central atom is underlined):

	Compound	Electron pair geometry	Molecular geometry	Polar / Non-polar
(i)	$\underline{Si}F_4$			
(ii)	$\underline{C}S_2$			
(iii)	$\underline{N}H_3$			
(iv)	H$\underline{C}$N			

[4 × 1½ marks]

d. Refer to the molecule below (*Note*: Hydrogen atoms are not shown),

(i) what is the hybridization for each of the carbon atoms in this molecule? [3 marks]



(ii) indicate the number of σ–bond(s) and π–bond(s) in this molecule. [1 mark]

Continued.....

Question 3 [20 marks]

a. Which of the following would you expect to have dipole-dipole intermolecular forces present?

HF CO_2 $CHCl_3$ NCl_3 CCl_4 H_2S

[2 marks]

b. Which of the following liquids would you predict to have the higher boiling point? Briefly explain.

(i) H_2O and H_2S
(ii) Ar and Kr

[2 × 2 marks]

c. Briefly define the following properties of liquids and explain how the property relates to the intermolecular force(s) present in the liquid.

(i) Viscosity
(ii) Surface tension

[2 × 2 marks]

d. How does each of the following affect the rate of evaporation from an open dish?

(i) intermolecular forces
(ii) temperature
(iii) surface area

[3 × 2 marks]

e. The rate law for the reaction:

$H_2 + I_2 \longrightarrow 2HI$ is Rate = $k[H_2][I_2]$.

How would the rate of the reaction change if:
(i) $[H_2]$ is doubled?
(ii) $[I_2]$ is doubled?
(iii) both $[H_2]$ and $[I_2]$ are doubled?
(iv) $[H_2]$ is doubled and $[I_2]$ is halved?

[4 × 1 mark]

Continued.....

Question 4 [20 marks]

a. An equilibrium is established in the reversible reaction represented by the following equation:

$$N_2O_4(g) \rightleftharpoons 2NO_2(g) \qquad \text{at } 25°C$$

The amount of reactant and product present in a 3.00 L vessel are found to be 1.56 g of NO_2 and 7.64 g of N_2O_4. What is the value of K_c for this reaction?
[Atomic mass: N = 14.0; O = 16.0]

[4 marks]

b. Given the equation for the photosynthesis reaction:

$$6CO_2(g) + 6H_2O(l) \rightleftharpoons C_6H_{12}O_6(s) + 6O_2(g) \qquad \Delta H = 2801 \text{ kJ}$$

How would the equilibrium change if the following changes in reaction conditions were made? Briefly explain why.
(i) increase the number of moles for CO_2
(ii) add a catalyst
(iii) decrease the temperature

[3 × 2 marks]

c. For each pair of acids, predict which one will be the stronger acid and explain why.

(i) H_2SO_4 (*aq*) and H_2SO_3 (*aq*)
(ii) HCl (*aq*) and HBr (*aq*)

[2 × 2 marks]

d. Calculate the pH of a solution containing 0.20 g of NaOH in 2000 mL of solution.
[Atomic mass: H = 1.0, Cl = 35.5, Na = 23.0, O = 16.0]

[4 marks]

e. (i) Identify the conjugate base of HPO_4^{2-} in the following reaction:

$$HCO_3^- + HPO_4^{2-} \rightleftharpoons H_2CO_3 + PO_4^{3-}$$

[1 mark]

(ii) Identify the conjugate acid of SO_4^{2-} in the following reaction:

$$CO_3^{2-} + HSO_4^- \rightleftharpoons HCO_3^- + SO_4^{2-}$$

[1 mark]

End of Page